IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
DO/EO/US

International Application No.	PCT/NO98/00347
International Filing Date:	November 25, 1998
Priority Application:	(No Priority Claim in PCT Application)
Priority Date:	(Not Applicable)
Applicant(s) for EO/US:	Morten MOEN et al.
Title of Invention:	METHOD FOR ESTABLISHING ALTERNATIVE ROUTES IN A TELECOMMUNICATION NETWORK

Box DO/EO/US
Assistant Commissioner for Patents
Washington, D.C. 20231

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Date of Deposit: May 22, 2001

I hereby certify that this paper, including the documents referred to therein, or fee is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above and is addressed to the:
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Type or Print Name ..... Carla Elkins
Signature Carla E. Elkins

Madam or Sir:

REQUEST FOR PCT NATIONAL ENTRY IN THE US UNDER 35 U.S.C. § 371 AND 37 C.F.R. § 1.495

This is an express request to begin national examination procedures of International Application Number NONE under 35 U.S.C. § 371 and 37 C.F.R. § 1.495 in the United States Patent and Trademark Office.

1. ☒ Enclosed are 9 pages of the specification, 4 pages of claims, and 1 page containing the abstract of International Application No. PCT/NO98/00347 as published.

2. ☒ Three sheets of formal drawings containing a total of four figures are enclosed.

PATENT

DOCKET NO.
28170-00028

3. ☒ The name(s), mailing address(es) and citizenship of the inventor(s) for this national application are not known to have changed since the publication of the International Application, and specifically are last known to be as follows:

Inventor	Name	Address	Citizenship
(1)	Morten MOEN	Hagasvingen 21C N-1472 FJELLHAMAR Norway	Norwegian
(2)	Reider SCHUMANN-OLSEN	Nøtteknekkeren 14 N-3400 LIER Norway	Norwegian

4. ☐ The International Bureau confirmed that it had received a certified copy of priority application as filed on during the international stage of this PCT application by mailing Form PCT/IB/304 to the Applicant(s) indicating such.

5. ☒ A proper Demand for International Preliminary Examination of the international application was made by the 19th month from the earliest claimed priority date. The United States was elected in the Demand. The International Bureau reported to the Applicant(s) that it had notified the EO/US in accordance with PCT Article 31(7) of its election for Chapter II proceedings.

6. ☒ Combined Declaration and Power of Attorney of the inventor(s): _____ Signed
__X__ Unsigned.

7. ☒ An Information Disclosure Statement Under 37 C.F.R. § 1.97(b) is enclosed, along with Form PTO-1449 and a copy of each reference identified on Form PTO-1449.

8. ☐ A Preliminary Amendment is enclosed.

9. ☒ The International Application was searched and examined in the English language.

10. ☐ A translation of the International Application into English (35 U.S.C. § 371(c)(2)) is enclosed.

11. ☐ A translation of the amendment(s) to the International Application under PCT Article 19 into English (35 U.S.C. § 371(c)(3)) is(are) enclosed.

12. ☐ A translation of the annex(es) to the International Preliminary Examination Report made under PCT Article 36 into English (35 U.S.C. § 371(c)(5)) is(are) enclosed.

13. ☐ Translation(s) of the following additional PCT documents is/are enclosed:

14. ☐ A Petition to Make Special For New Application Under MPEP § 708.02, VIII is enclosed, along with Form PTO-1449, and a copy of each reference identified on Form PTO-1449.

15. ☐ This entity and/or independent inventor qualifies for small entity status under 37 C.F.R. § 1.9(f) and/or § 1.27(b). The following supportive documentation reflecting such is attached:

16. ☒ In determining the Basic Fee, the following aspects of the progression of the PCT application were considered:

Searching Authority	Swedish Patent Office
Examining Authority	Swedish Patent Office.

17. ☒ The filing fee is calculated by adding the appropriate Basic Fee to the fees for the number and types of claims presented for national entry under 37 C.F.R. § 1.492, specifically:

FOR	NUMBER	NUMBER EXTRA	RATE	CALCULATION
TOTAL CLAIMS	53 -20=	33	x $ 18.00 =	$ 594
INDEPENDENT CLAIMS	1 -3=	-2	x $ 80.00 =	$ 0
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			x $ 270 =	$ 270
			BASIC FEE	$ 1000
		TOTAL OF ABOVE CALCULATIONS =		$ 1864
REDUCTION BY ½ FOR FILING BY SMALL ENTITY OR INDEPENDENT INVENTOR (Note 37 C.F.R. §§ 1.9, 1.27, 1.28)				0
			Total =	$ 1864

18. ☒ A check in the amount of $1,864.00 for the application fee is enclosed.

19. ☒ The Commissioner is hereby authorized to charge fees under 37 C.F.R. § 1.492 which may be required to complete national entry, or credit any overpayment to Deposit Account No. 10-0447 of JENKENS & GILCHRIST, P.C. The reference number 28170-00028 should be included in any deposit account transactions. A duplicate copy of this sheet is enclosed.

20. ☒ Address all future communications to:

Stanley R. Moore, Esq.
JENKENS & GILCHRIST, P.C.
1445 Ross Avenue, Suite 3200
Dallas, Texas 75202-2799.

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28170-00028

21. ☒ Also enclosed:

1. Copy of International Preliminary Examination Report (IPER) as Prepared by IPEA/SE (5 pages);
2. Amended Sheets 10 - 12 as Attached to IPER (3 pages);
3. Certificate of Express Mailing No. EL628365532US; and
4. Confirmation Postcard.

Respectfully submitted,
JENKENS & GILCHRIST, P.C.

Stanley R. Moore
Reg. No. 26,958

JENKENS & GILCHRIST, P.C.
1445 Ross Avenue, Suite 3200
Dallas, Texas 75202-2799
Telephone: (214) 855-4500
Facsimile: (214) 855-4300

METHOD FOR ESTABLISHING ALTERNATIVE ROUTES IN A TELECOMMUNICATION NETWORK

Field of the invention

The present invention relates to a method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising transmission links for duplex operation.

More specifically the present invention relates to a method for constructing an autonomous self healing ring in a 2 MBit/s leased line telecommunication network in order to create redundancy in the network in case of transmission failure.

Technical background

THE PROBLEM AREA

The problem area concerns building a transmission network between digital cross-connects in such a way that alternative routes are introduced in case of transmission failures. This is desirable in order to keep the network up and running when failures occur. As described below, earlier solutions have involved expensive dual lines or slow remote management involvement. In certain applications, such as cellular networks, it is important that the solution is at low cost and that the network disturbance does not last so long as to disrupt on-going traffic.

KNOWN SOLUTIONS

Known solutions for providing network protection in a 2 MBit/s telecommunications network include

- 1+1 protection
- N+1 protection
- NMS re-routing
- Ring topologies

1+1 protection uses duplicated lines between nodes. Traffic is sent out identically on both lines, and the receiving node chooses the 'best' line. The entire protection operation including detection of problems and switching of input source is performed at the receiving end. Switching is autonomously and fast and does not include network management system involvement.

N+1 protection adds one extra line to a group of N lines. The stand-by line will take over for any of the other lines in case of failure. There is no traffic on the stand-by line before the failure, and switching will have to take place at both ends.

In the case of NMS re-routing, the network is generally built with extra capacity in the lines. In case of failure, the traffic from the failed line is re-routed on other lines. This operation is conducted by a network management system (NMS).

There are ring protection solutions that use the fact that any node in a ring may be reached in two ways. They mainly fall into two groups:

- Nodes in the ring keep an updated database of all nodes in the ring with information on which time slots belong to these nodes. When a fault occurs, the ring is split and time slots are selectively transmitted on

the right or left branch according to this information.

- When a fault occurs, information is sent to a central management system that decides on the re-configuration of the nodes in the ring.

PROBLEMS WITH KNOWN SOLUTIONS

The problem with the 1+1 protection has been that this is a very costly alternative as every line segment must be duplicated.

The N+1 solution is a limited solution since it can only protect a number of line segments between the same nodes.

The NMS re-routing solution is generally too slow for application requiring connections to stay up. For instance, the GSM traffic in cellular networks will go down if the protection is based on NMS re-routing.

The problem with existing ring solutions is that they generally are more complex and thus more expensive and subject to errors than the suggested ring solution. Also, in the case of needing to use a central management system for restoration, switching is not fast enough to be used in for instance cellular networks.

Objects of the invention

An object of the present invention is to provide a method for establishing alternative routes in a telecommunication network which generally is not hampered with the problems enfaced with known solutions.

Another object of the present invention is to provide a method which is less complex and less expensive as well

as less subject to errors than previously suggested ring solutions.

Still another object of the present invention is to provide a method wherein the use of a central management system for restoration is reduced to a minimum.

Yet another object of the present invention is to provide a method which is autonomously self healing, and wherein the healing is accomplished in a minimum of time.

Another object of the present invention is to provide a method wherein the self healing means are included in the nodes of the network.

Brief summary of the invention

These objects are achieved in a method as stated in the preamble, which according to the present invention is characterized by

- arranging said network in one or more initial rings including duplex operation between the nodes included in each ring, and by
- arranging said nodes such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path.

Further objects and advantages of the present invention will appear from the following description taken in conjunction with the enclosed drawings, as well as from the enclosed patent claims.

Brief disclosure of the drawings

Fig. 1 is a simplified sketch illustrating an initial protected ring wherein the present invention has been implemented.

Fig. 2 is a simplified sketch illustrating details in one of the nodes which are tied into the ring by dropping and inserting time slots.

Fig. 3 is a simplified sketch, similar to Fig. 1, illustrating the ring after switching to redundancy mode.

Fig. 4 is a simplified sketch illustrating a ring configuration before, during and after a transmission fault occurs.

Detailed description of embodiments

It is to be understood that the present invention has been developed in connection with 2 Mb/s transmission links which are always duplex, but it is to be understood that the general principle of the present invention can be applied in any telecommunication network comprising transmission links for duplex operation.

In Fig. 1 there is illustrated an example of a ring including 4 nodes, designated A, B, C, D, respectively. Such a ring may be included as one of more rings in a network and between each node in the ring in question there is established a duplex operation.

In the following it is assumed that the example of the ring illustrated in Fig. 1 is established for a 2 Mb/s transmission link.

2 MBit/s transmission links are always duplex. There is symmetrical transmission in both directions. This symmetrical nature of the 2 Mbit/s network makes it possible to set up a ring where all time slots are transmitted in one direction while the other direction is not used. The empty direction may then be used as a stand-by path. The initial ring is shown in Fig. 1. The normal direction is called the OK direction. The spare direction is called the ERROR direction.

By using bits in time slot 0, it is possible to monitor each 2 Mbit/s section in the ring for both directions. A transmission fault on a section can thus be detected at both ends and re-routing of the time slots to the spare capacity may be done in both affected nodes.

The fault criteria may be:

LIS - Loss of Incoming Signal
LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

For a cross-connect node, the timing information is usually taken from one of the incoming line signals. In the protected ring, timing is propagated along with the normal traffic direction. When the traffic switches, the timing will also have to switch.

Other nodes are tied into the ring by dropping and inserting time slots as shown in Fig. 2. Most of the time slots entering the node in the OK direction is fed right through the node. Time slots destined for the connected equipment are dropped off to the port where this equipment is connected. Time slots from the connected equipment is inserted into the OK direction thus keeping the one-way traffic in the ring.

If the ring should be treated as a sub-network connecting to a central node such as the BSC in cellular networks, all time slots would be dropped towards this node.

When a fault occurs on a section in the ring the two nodes in both ends of that section will be triggered by the switching criteria. The two nodes will then re-configure so that traffic that normally would be sent out on the faulted section will be routed back onto the ERROR direction. Traffic that normally would be taken from the faulted section will instead be taken from the ERROR direction. This is shown in Fig. 3 where the fault occurred between nodes C and D.

If, in Fig. 3, node D received timing information from node C, its timing source would have to change. This is trivial for node D because this node is next to the faulty section and is able to detect the switching criteria. However, had there been more nodes between nodes D and A, for example nodes DX, DY and DZ, these would also have to change timing sources. These nodes do not have access to the same fault information as have nodes D and C.

To make these nodes aware of the need to switch timing source, one of the spare bits in time slot 0 is used as a timing source bit. On ports used as timing source, this bit is sent in the high state. On all other ports the bit is sent in the low state. It is not legal to use a port with the incoming timing source bit in the high state as a timing source. As node D starts using the other (non faulty) port as timing source, the timing source bit will force the node at the other end to change timing source if timing previously was taken from node D. This will ripple through all possible nodes between nodes D and A until the complete rightmost branch takes timing from node A. Clock stability requirements secure that

the timing change information is transported before bit-slip will occur.

In other words when the node D immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node DX in the redundancy ERROR direction to change its timing source if timing was previously taken from said next to fault node D, which forcing will take place also in any still further nodes DY, DZ arranged between said next to fault node D and said node A being connected to a central node CN.

In Fig. 4 there is illustrated another ring configuration between four other nodes R, S, T and U, wherein a transmission fault has occurred between the nodes S and T.

Fig. 4 further illustrates how ports used as timing source will send one of the spear bits in time slot 0 in the high state, whereas on all other ports this bit is sent in the low state. Further, Fig. 4 illustrates that when node S, due to a transmission fault, will have to use the redundancy or error path, it will establish its output port as a timing source, i.e. especially for the closest node R, which further communicates the redundancy path to node U and node T, in which latter node T the incoming of time slots on the redundancy port thereof will set the associated timing source bit to high state. This high state will be transferred from node T to node U, and further to node R, but then via the OK path, until the correct timing configuration is established.

Advantages

There are several advantages to this invention. They may be summarised as follows:

Usually redundancy creates largely increased costs due to duplication of transmission capacity. The suggested redundant ring only needs one extra section and the inherent spare capacity in duplex lines to protect a number of other sections and is thus less costly.

The switching of time slots and timing sources are completely autonomous and does not require any interaction with a remote management system. Switching is thus rapid and restoration of connections is done with minimum interruption of traffic.

Because only the two nodes in either end of the faulty section is actively involved in the switching, there is no need for additional complexity in order to synchronise other nodes in the ring with configuration information. The suggested solution is thus less complex, less expensive and more reliable.

Patent claims
(amended 04.01.2000)

1. Method for establishing alternative routes in a telecommunication network, especially in case of transmission failure, and more specifically in a telecommunication network comprising 2 Mbit/s transmission links and nodes with G.704 framing for duplex operation, wherein said network is arranged in one or more initial rings including duplex operation between the nodes included in each ring, characterized by

- Arranging said nodes, due to the symmetrical nature of the 2 Mbit/s network, such as to let all time slots be transmitted in one and the same direction (OK direction) of the ring in question whilst maintaining the opposite direction (ERROR direction) as a standby or redundancy path until alerted by a specific time slot reflecting the occurrence of a fault,

- Providing a time slot, preferably time slot 0, with alerting means that are adapted to monitor each section in the ring in question for both directions, said alerting means being defined by the bit configuration of said time slot.

2. Method as claimed in claim 1, characterized in that each node is provided with detection means adapted for detecting a section transmission fault both at the incoming or at the outgoing ports thereof, i.e. allowing detection of a transmission fault on a section at both ends of said section.

3. Method as claimed in claim 1 or 2, characterized by letting inter alia the following fault criteria determine the re-routing of the time slots:

LIS - Loss of Incoming Signal

LFA - Loss of Frame Alignment
RAI - Remote Alarm Indication

4. Method as claimed in any of the preceding claims, characterized in that during normal and initial ring operation the timing information will preferably be taken from one of the incoming signals, i.e. signals being propagated along the normal (OK) direction.

5. Method as claimed in any of the preceding claims, characterized in that when a fault occurs on a section in the ring the two nodes at the end of that faulty section will be triggered by one or more appropriate switching criteria, for thereby reconfiguring the two nodes in question for routing the traffic which should have been sent via the faulty section to its destination node or nodes via the duplex channel in the opposite (ERROR) direction.

6. Method as claimed in any of the preceding claims, characterized in that when a fault occurs in a section between two nodes then the node immediately following the faulty section in the previous normal (OK) direction will have its timing source changed upon detection of the appropriate fault occurrence switching criteria, and that any further node or nodes being arranged between said immediately following node and a node (A) being connected to a central node (CN) will also have its or their timing sources changed.

7. Method as claimed in claim 6, characterized in that one of the spare bits in time slot 0 is used as a timing source bit and that on ports being used as a timing source this bit will be given a first state, preferably the high state, whereas all other ports will have the same spare bit sent in the opposite state, i.e. preferably the low state.

8. Method as claimed in claim 7, characterized in that when the node (D) immediately following the faulty section starts using the other non-faulty/redundancy channel port as timing source, then the timing source bit will force the next node (DX) in the redundancy (ERROR) direction to change its timing source if timing was previously taken from said next to fault node (D), which forcing will take place also in any still further nodes (DY, DZ) arranged between said next to fault node (D) and said node (A) being connected to a central node (CN).

9. Method as claimed in any of the preceding claims, characterized in that the transport of the timing change information sent or rippled through nodes involved in a redundancy (ERROR) path, i.e. receiving signals thereon but transmitting signals on the remaining normal (OK) path, is adapted in relation to clock stability requirement so as to avoid the occurrence of bit slip.

10. Method as claimed in any of the preceding claims, characterized in that the method is applied in an autonomous manner, without any interaction with a remote management system (RMS).

11. Method as claimed in any of the preceding claims, characterized in that the method is applied as an autonomous self healing ring, especially in a 2 Mb/s leased line telecommunication network so as to create redundancy pathways therein in case of transmission failure.

FIG.1

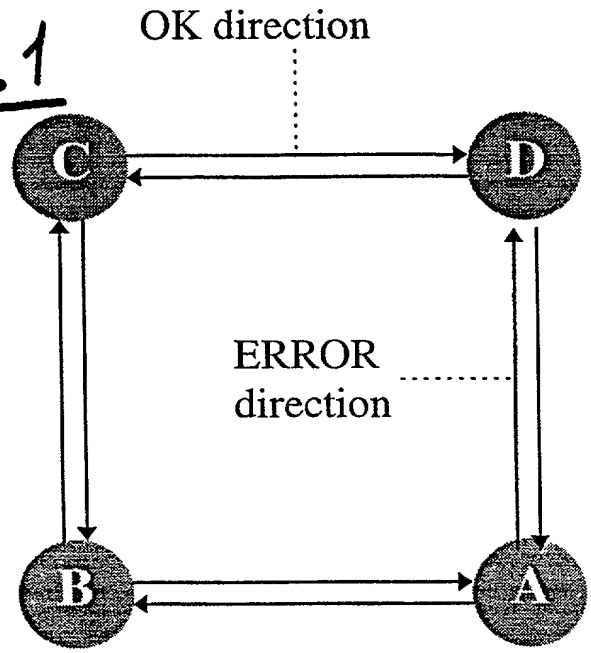
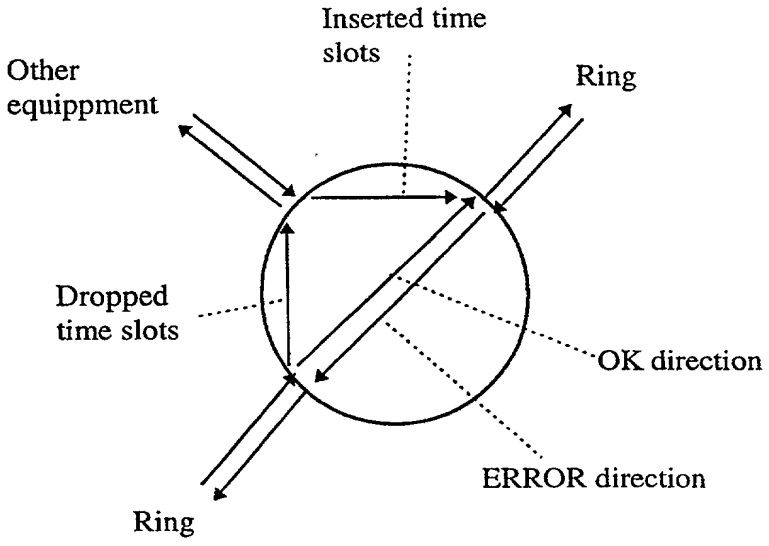

OK direction
C
D
ERROR
direction
B
A

FIG.2


Inserted time
slots
Other
equippment
Ring
Dropped
time slots
OK direction
ERROR direction
Ring

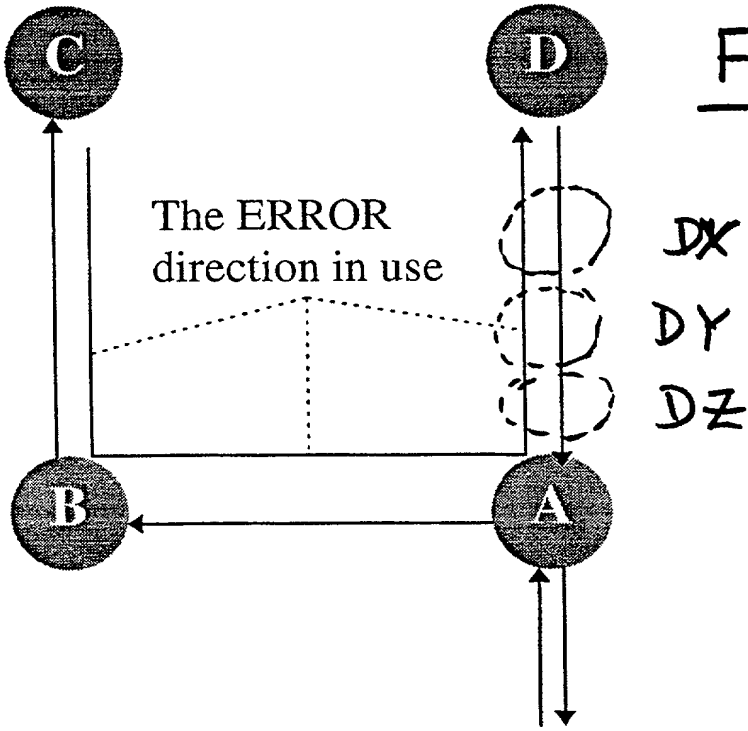
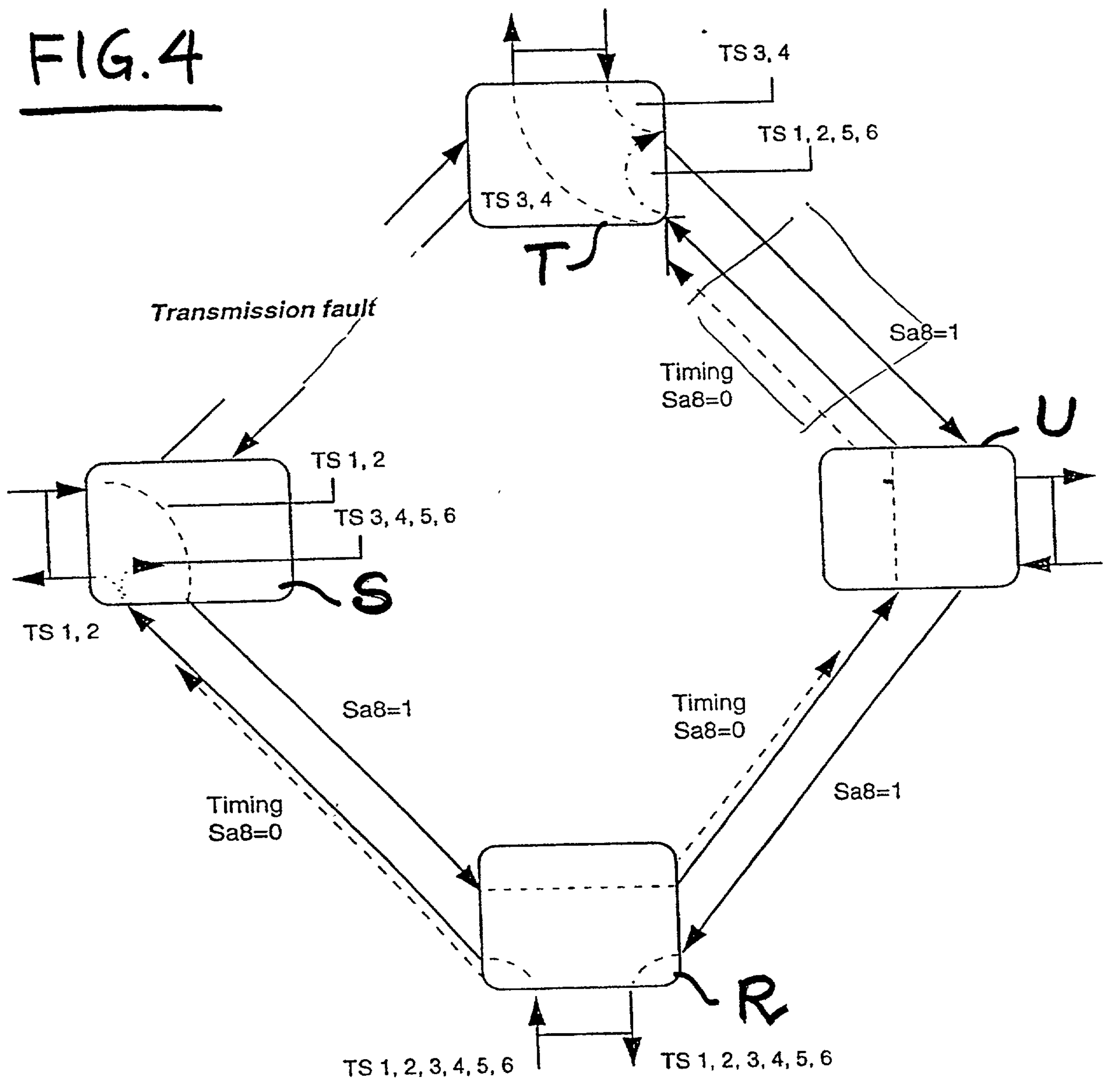


FIG.3

FIG.4



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PATENT

DOCKET NO.: 28170-00028
(145493/ØS/KR/-)

RULES 63 AND 67 (37 C.F.R. 1.63 and 1.67)
DECLARATION AND POWER OF ATTORNEY

FOR UTILITY/DESIGN/CIP/PCT NATIONAL APPLICATIONS

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **METHOD FOR ESTABLISHING ALTERNATIVE ROUTES IN A TELECOMMUNICATION NETWORK**, the specification of which: (mark only one)

X	(a)	is attached hereto.
__	(b)	was filed on _____ as Application Serial No._____ and was amended on _____ (if applicable)
__	(c)	was filed as PCT International Application No. PCT/_____ on _____ and was amended on _____ (if applicable).
__	(d)	was filed on ___ as Application Serial No. ___ and was issued a Notice of Allowance on ___.
__	(e)	was filed on _____ and bearing attorney docket number _____ _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above or as allowed as indicated above.

I acknowledge the duty to disclose all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56. If this is a continuation-in-part (CIP) application, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability of the application as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the

application on which my priority is claimed or, (2) if no priority is claimed, before the filing date of this application:

PRIOR FOREIGN PATENTS

Number	Country	Month/Day/Year Filed	Date first laid-open or Published	Date patented or Granted	Priority Claimed Yes	No
NONE						

I hereby claim the benefit under 35 U.S.C. § 120/365 of any United States application(s) listed below and PCT international applications listed above or below:

PRIOR U.S. OR PCT APPLICATIONS

Application No. (series code/serial no.)	Month/Day/Year Filed	Status(pending, abandoned, patented)
PCT/NO98/00347	**November 25, 1998**	**Pending**

I hereby appoint:

TIMOTHY G. ACKERMANN, Reg. No. 44,493
BENJAMIN J. BAI, Reg. No. 43,481
JOSEPH M. BEAUCHAMP, Reg. No. 46,544
MARY JO BOLDINGH, Reg. No. 34,713
MARGARET A. BOULWARE, Reg. No. 28,708
DANIEL J. BURNHAM, Reg. No. 39,618
THOMAS L. CANTRELL, Reg. No. 20,849
RONALD B. COOLLEY, Reg. No. 27,187
THOMAS L. CRISMAN, Reg. No. 24,846
STUART D. DWORK, Reg. No. 31,103
WILLIAM F. ESSER, Reg. No. 38,053
ROGER J. FRENCH, Reg. No. 27,786
JANET M. GARETTO, Reg. No. 42,568
MARK GATSCHET, Reg. No. 42,569
JOHN C. GATZ, Reg. No. 41,774
RUSSELL J. GENET, Reg. No. 42,571
GERALD H. GLANZMAN, Reg. No. 25,035
LEKHA GOPALAKRISHNAN, Reg. No. 46,733
J. KEVIN GRAY, Reg. No. 37,141
KEITH P. GRAY, Reg. No. 46,738
STEVEN R. GREENFIELD, Reg. No. 38,166
JOSHUA A. GRISWOLD, Reg. No. 46,310
J. PAT HEPTIG, Reg. No. 40,643
SHARON A. ISRAEL, Reg. No. 41,867
JOHN R. KIRK JR., Reg. No. 24,477
PAUL R. KITCH, Reg. No. 38,206
TIMOTHY M. KOWALSKI, Reg. No. 44,192
JAMES F. LEA III, Reg. No. 41,143
HSIN-WEI LUANG, Reg. No. 44,213
ROBERT W. MASON, Reg. No. 42,848
ROGER L. MAXWELL, Reg. No. 31,855
LISA H. MEYERHOFF, Reg. No. 36,869
STANLEY R. MOORE, Reg. No. 26,958
RICHARD J. MOURA, Reg. No. 34,883
P. WESTON MUSSELMAN JR. Reg No. 31,644
RAMA B. NATH, Reg. No. 27,072
DANIEL G. NGUYEN, Reg. No. 42,933
MICHAEL K. NUTTER, Reg. No. 44,979
SPENCER C. PATTERSON, Reg. No. 43,849
RUSSELL N. RIPPAMONTI, Reg. No. 39,521
ROSS T. ROBINSON, Reg. No. 47,031
STEPHEN G. RUDISILL,, Reg. No. 20,087
HOLLY L. RUDNICK, Reg. No. 43,065
J.L. JENNIE SALAZAR, Reg. No. 45,065
KEITH W. SAUNDERS, Reg. No. 41,462
JERRY R. SELINGER, Reg. No. 26,582
JAMES O. SKARSTEN, Reg. No. 28,346
ZACHARY J. SMOLINSKI, Reg. No. 47,100
GARY B. SOLOMON, Reg. No. 44,347
STEVE Z. SZCZEPANSKI, Reg. No. 27,957
ANDRE M. SZUWALSKI, Reg. No. 35,701
ALAN R. THIELE, Reg. No. 30,694
TAMSEN VALOIR, Reg. No. 41,417
BRIAN D. WALKER, Reg. No. 37,751
GERALD T. WELCH, Reg. No. 30,332
HAROLD N. WELLS, Reg. No. 26,044
WILLIAM D. WIESE, Reg. No. 45,217

all of the firm of **JENKENS & GILCHRIST, a Professional Corporation**, 1445 Ross Avenue, Suite 3200, Dallas, Texas 75202-2799, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, provisionals thereof, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, and extensions thereof and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney and to file and prosecute any international patent application filed thereon before any international authorities, and I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/organization who/which first sent this case to them and by

whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct them in writing to the contrary.

Please address all correspondence and direct all telephone calls to:

Stanley R. Moore, Esq.
Jenkens & Gilchrist, P.C.
1445 Ross Avenue, Suite 3200
Dallas, Texas 75202-2799
214/855-4500
214/855-4300 (fax)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAMED INVENTOR(S)

1	Morten MOEN **Full Name**	**Inventor's Signature**	18/7 2000 **Date**
	Hagasvingen 21C N-1472 FJELLHAMAR, Norway NOX **Residence** (city, state, country)		Norwegian **Citizenship**
	Hagasvingen 21C N-1472 FJELLHAMAR, Norway **Post Office Address** (include zip code)		

(FOR ADDITIONAL INVENTORS, check here X and add additional sheet for inventor information regarding signature, name, date, citizenship, residence and address)

PATENT

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2	Reider SCHUMANN-OLSEN **Full Name**	R. Schumann-Olsen **Inventor's Signature**	09.08.2004 **Date**
	Nøtteknekkeren 14 N-3400 LIER, Norway NOR **Residence** (city, state, country)		Norwegian **Citizenship**
	Nøtteknekkeren 14 N-3400 LIER, Norway **Post Office Address** (include zip code)		